Code No: RT22044 **R13** SET - 1

II B. Tech II Semester Regular/Supplementary Examinations, April/May-2017
EM WAVES AND TRANSMISSION LINES
(Com to ECE, EIE)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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PART-A

1. a) State the Divergence theorem and explain its significance.
   b) State and explain Faraday's law for induced e.m.f.
   c) Define Uniform plane wave and explain the properties.
   d) What is Total internal reflection? Explain.
   e) Explain different losses existed in Transmission lines.
   f) Write short notes on the applications of smith chart. (3M+4M+4M+3M+4M+4M)

PART-B

2. a) State Ampere's circuital law. Specify the conditions to be met for determining magnetic field strength **H** based on Ampere's circuital law.
   b) An infinitely long straight conducting rod of radius 'a' carries a current of **I** in positive Z-direction. Using Ampere's circuital law, find **H** in all regions and sketch the variation of **H** as a function of radial distance. If is I=3mA and a=2cm, find **H** and **B** at (0, 1cm, 0) and (0, 4cm, 0) (6M+10M)

3. a) What is the inconsistency in Ampere's law? How is it rectified by Maxwell?
   b) Differentiate Conduction and Displacement currents. And show that the displacement current through the capacitor is equal to the conduction current. (8M+8M)

4. a) Derive the wave equation in **E** and **H** for free space conditions.
   b) A plane wave is propagating in a medium having the properties $\mu_r = 4; \varepsilon_r = 36; \sigma = 1$ s/m and **E**= 100 $e^{-\alpha z}\cos(10^8 t-\beta z)a_x$ V/m, Determine the associated magnetic field. (8M+8M)

5. a) State and prove Poynting theorem. Explain its significance
   b) Find the power flow through a coaxial cable by using Poynting theorem. (8M+8M)

6. a) Derive the Characteristic impedance of a transmission line in terms of its line constants.
   b) A telephone wire of 20m long has the following constants per loop km. Resistance 90Ω, capacitance 0.062μF, inductance 0.001H and leakage 1.5×10^{-6}mhos. The line is terminated in its characteristic impedance and potential difference of 2.1V having a frequency of 1000Hz is applied at the sending end. Calculate (i) characteristic impedance (ii) wave length (iii) the velocity of propagation. (8M+8M)

7. a) Explain the significance and design of single stub impedance matching. Discuss the factors on which stub length depends?
   b) Derive the expression for input impedance of a transmission line. (8M+8M)
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PART-A

1. a) State Gauss's law and explain its limitations.
   b) What is Transformer e.m.f? Explain.
   c) Define Polarization and explain the properties.
   d) What is Brewster angle? And explain its significance.
   e) Define Distortion less transmission line and explain the condition with necessary mathematical expressions.
   f) What are different applications of smith chart? (4M+3M+4M+3M+4M+4M)

PART-B

2. a) What is continuity equation? Derive the expression for it
   b) Two uniform line charges of density 8nC/m are located in a plane with y=0 at x= ±8m. Find the **E**-field at a point **P** (5, 4, 8) m. (8M+8M)

3. a) Derive the Boundary conditions for the tangential and normal components of Electrostatic fields at the boundary between two perfect dielectrics.
   b) X-Z plane is a boundary between two dielectrics. Region y<0 contains dielectric material with ε_{r1}=2.5 while region y>0 has dielectric with ε_{r2}=4.0. If **E**= $-30a_x+5a_y+70a_z$ V/m, find normal and tangential components of the E- field on both sides of the boundary. (8M+8M)
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Code No: RT22044 **R13** SET - 2

4. a) A plane wave travelling in positive X-direction in a loss less unbounded medium having permeability 4.5 times that of free space and permittivity twice that of free space. Find the Phase velocity of the wave. If the electric field **E** has only a Y-component with amplitude of 20V/m, find the amplitude and the direction of Magnetic field intensity.
   b) For good dielectric derive the expressions for α,β,v and η (8M+8M)

5. a) Explain the difference between the Intrinsic impedance and the Surface impedance of a conductor. Show that for a good conductor, the surface impedance is equal to the intrinsic impedance.
   b) An EM wave in free space is incident normally on a dielectric whose ε_r=5.0. Find the Reflection and Transmission coefficients. (8M+8M)

6. a) A loss less transmission line has a capacitance of 50pF/m, and an inductance of 200nH/m. Find the characteristic impedance for section of a line of 10m long and 500m long.
   b) Using the general line equations obtain an expression for the input impedance of a transmission line. (8M+8M)

7. a) Discuss about Single and Double stub matching.
   b) Explain the principle of impedance matching with quarter wave transformer. (8M+8M)

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2. Answer **ALL** the question in **Part-A**
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PART-A

1. a) Explain the concept of Potential with necessary equations.
   b) What is Motional e.m.f? Explain.
   c) Differentiate Conductor and Dielectric.
   d) Define Poynting Theorem and Poynting Vector.
   e) What is Loading? And explain different types of loading.
   f) Explain about Double stub matching. (4M+4M+3M+3M+4M+4M)

PART-B

2. a) State and explain the Biot-Savart's law relating magnetic field produced at a point due to the current in a small elemental wire.
   b) A thin ring of radius 5 cm is placed on plane Z=1cm, so that its center is at (0,0,1) cm. If the ring carries 50mA along $\mathbf{a}_\varphi$. Find **H** at (i) (0,0,-1)cm (ii) (0,0,10) cm (8M+8M)

3. a) Derive Maxwell's equations in Integral and Differential forms for time varying fields
   b) Do the fields $E = E_m \sin x \sin t\, \mathbf{a}_y$ and $H = \frac{E_m}{\mu_0} \cos x \cos t\, \mathbf{a}_z$ satisfy Maxwell's Equations? (9M+7M)

4. a) Derive the expressions for α and β in a good conductor.
   b) Discuss about wave propagation in free space (8M+8M)

5. a) Derive an expression for Reflection coefficient when a wave is incident on a dielectric obliquely with parallel polarization.
   b) In a plane wave travelling in a free space has an average poynting vector of 5watts/m^2. Find the average energy density (10M+6M)

6. a) Starting from the equivalent circuit, derive the transmission line equation for **V** and **I** in terms of the source parameters.
   b) The characteristic impedance of a certain line is $710\angle -16^0$and the frequency is 1 KHz. At this frequency the Attenuation is 0.01neper and the phase function is 0.035 rad/km. calculate the Resistance, Conductance, Inductance, Capacitance per kilometer and velocity of propagation. (8M+8M)

7. a) Explain about quarter wave transformer.
   b) A low loss transmission line of 100 Ω characteristic impedance is connected to a load of 400 Ω. Calculate the Reflection Coefficient and Standing wave ratio. (9M+7M)
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2. Answer **ALL** the question in **Part-A**
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PART-A

1. a) State Biot-Savart's law and Explain.
   b) What is the significance of Displacement current density?
   c) Define Linear homogeneous medium. And list its properties?
   d) What is the difference between Reflection and Refraction of a plane wave? Explain.
   e) Discuss about infinite lines
   f) Explain how VSWR can be determining using smith chart. (4M+3M+3M+4M+4M+4M)

PART-B

2. a) State Coulomb's low force between any two point charges, and indicate the units of the quantities in the force equation.
   b) Point charges 1mC and -2mC are located at (3,2,-1) and (-1,-1,4) respectively. Calculate the electric force on a 10nC charge located at (0,3,1) and Electric field intensity at that point. (8M+8M)
3. a) Derive the Boundary conditions for the tangential and normal components of Magneto static fields at the boundary between two perfect dielectrics.
   b) Write the Maxwell's equations for time varying fields in integral and differential forms with their work statements. (8M+8M)
4. a) Define Uniform plane wave. Prove that Uniform plane wave does not have field components in the direction of propagation.
   b) A uniform plane wave propagating in a medium has $E = 2e^{-\alpha z}\sin(10^8\, t - \beta z)\mathbf{a}_y$ V/m. If medium is characterized by ε_r=1, μ_r=20, σ =3mhos/m, find **α** and **β**. (8M+8M)
5. a) Define Surface impedance and explain how it exists.
   b) Derive the expression for Reflection and Transmission coefficients of an EM wave when it is incident normally on a dielectric. (8M+8M)
6. a) What is Distortion? Derive the conditions for the distortion less transmission line.
   b) A coaxial line with an outer diameter of 8mm has 50Ω characteristic impedance. If the dielectric constant is 1.60, calculate the inner diameter. (10M+6M)
7. a) Derive the relation between Reflection coefficient and Characteristic impedance of a transmission line.
   b) A 100Ω loss less line connects a signal of 100 KHz to load of 140 Ω. The load power is 100mW.Calculate (i) Voltage reflection coefficient (ii) VSWR (iii) Position of V_{max}, I_{max}, V_{min} and I_{min}. (8M+8M)
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